Impact of the electrical voltage transient nature of the auxiliary power system on the DC-DC converters in hybrid, PHEV and BEV automobiles

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Numerous design challenges have been encountered due to electrical transients in the circuits and subsystems available in automobiles. These challenges became prominent, especially during the transition from traditional fuel-based automobiles to Hybrids, PHEVs (Plug-in hybrid electric vehicles) and BEVs (Battery EV). Traditional auxiliary operations such as air conditioning and heating directly from the HV battery, while keeping the galvanic isolation of high-voltage (HV) and low-voltage (auxiliary) regions in the automotive supply system, are examples of the associated design challenges encountered. Moreover, EM coupling and transient vulnerability issues affect the sensitivity of deliberate sophisticated solid-state control circuits like DC-DC converters. Furthermore, the transient nature of the loads beyond the acceptable power quality standards will impart severe stresses on the auxiliary system. In battery-supported automobiles, the DC-DC converter with an onboard 200-800 V high voltage battery generates and caters 12 V_{DC} (or 48 V_{DC}) to power up auxiliary elements such as headlights, other lights, wipers, winkers, etc. Thus, measurements and analysis have been carried out to identify the risk levels of such transients for vehicular control, in preference to the DC-DC converters which connect the HV battery and auxiliary side. The aforementioned transient measurements were carried out covering a fleet of late-model hybrid and PHEV automobiles using a Tektronix P6015A High Voltage Probe and a PicoScope 3206A Oscilloscope with 200 MHz resolution. There were 354 transients observed in this study and amplitudes of the voltage transients were recorded up to 45.20 V. The rise time of the transients were recorded within the range of 0.3 – 50 μs and respective burst durations were up to 0.5 ms. The recorded transient amplitudes exceed the rated 13.8 V output value of the commercially available DC-DC converters. These findings will be an eye-opener to the current market of electric vehicles. Thus, it is suggested that manufacturers should improve the respective withstand capabilities against the transients generated in electromechanical segments in EVs.

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